The genera *Lavinia*, *Siboma*, *Algansea*, *Tigoma*, *Cheonda*, *Gila*, *Ptychochilus* and *Mylochilus*, are closely related to each other, and cannot be distributed among different subfamilies, as has been attempted. Indeed, some of the genera so separated are so intimately allied, that their claims to generic distinction are extremely doubtful. *Siboma* appears to be nearly allied to *Lavinia*, and includes only the *S. crassicauda*, the *S. atraria* belonging rather to *Algansea*. *Algansea* itself and *Tigoma* are scarcely distinguishable, they differing only in the pharyngeal teeth,—*Algansea* having teeth 5—5, increasing upwards, while *Tigoma* has, normally, 2 | 5—5 | 2: both groups have narrow suborbitals. *Cheonda* should be restricted to *C. Cooperi*. The difference between *C. cærulea* and species of *Tigoma* are not evident. *Gila* and *Ptychochilus* both require revision. *Mylochilus* and *Mylopharodon* do not differ generically, wherefore the former name alone can be retained. The genus *Acrochilus* of Agassiz, referred to *Lavinia* by Girard, has no affinity to that group, being nearly related to *Chondrostoma*, as shown by Agassiz, who has well described its peculiarities, while *Lavinia* as well as *Tigoma*, *Algansea*, &c., are closely related to the European *Leucisci*. As I propose, on another occasion, to give the full generic characters, as well as anatomy of the genera of Western American Cyprinoids, I defer till then further consideration of their affinities.

Observations on the EOCENE LIGNITE FORMATION of the United States.

BY T. A. CONRAD.

OLDER EOCENE OR LONDON CLAY.

Lignite Epoch.

Some years ago I visited a marl deposit near Long Branch, Monmouth Co., New Jersey, in which casts of a few shells presented an eocene character. Observing in Vanuxem's cabinet a specimen of what is now known to be *Aturia ziczac*, I described it in the Journal of the Academy of Natural Sciences, vol. i. 2d series, p. 129, and referred the marl, principally on account of the presence of this shell, to the eocene era. I also described an imperfect cast of the same species as *Nautilus angustatus*, in Dana's Report on the Geology of the Exploring Expedition, which was found at Astoria in Oregon, in company with many shells which I mistook for miocene forms; but a more extended acquaintance with eocene types shows their older tertiary relations, and their matrix to be synchronous with the London Clay of Sheppey, Highgate and Bracklesham. Professor Cook has lately sent me a box of specimens of similar age from Shark River, Monmouth Co., N. Jersey, collected by Dr. Kneiskern. In company with *Aturia ziczac* there are imperfect specimens of *Nautilus Lamarckii*, Deshayes, another older eocene form of the Paris basin and of Belgium. Fruits also occur in this bed, referrible to the genera *Nipadites* and *Mimosites*, showing the tropical or semitropical climate of the era, and giving evidence of the intimate relations of the deposit to the Brandon and Mississippi Lignite strata. Indeed, it seems clear that this Shark River marl was the bed of the oldest eocene ocean, and that the flora of the Brandon and Southern tertiary epoch flourished at the same time. The local, circumscribed character of the Brandon Lignite is attributed by Prof. Lesley to its having filled a deep depression, thus escaping the denuding forces which swept all traces of it away over a wide region that it once covered. The locality at Mont Alto, near Chambersburg, described by Prof. Lesley, is doubtless a locally preserved fragment of a vast formation once deposited over the Appalachian slope to the very base of the mountain range, and occupying a large space in South Carolina, Georgia, Alabama and Mississippi, and in fact, extending to the Pacific as far north as Vancouver's Island.

Dana's map of the cretaceous epoch gives a general view of the United States at this time, supposing what was then ocean had become land and fresh water.

It is probable that the estuary deposits of Upper Missouri are the base of the older eocene, and the fresh-water shells are the earliest tertiary types of this continent. The species of *Vivipara* resemble the eocene forms of the Paris basin. According to Meek and Hayden these beds are more than 2000 feet thick.

Vanuxem was the first geologist who stated that a lignite bed is situated in South Carolina between the cretaceous and eocene strata, and Tuomey has since described several localities in that State and one in Clark Co., Alabama, represented by No. 6 of his Bashia Creek section; and No. 2 of the section represents the Marlborough and Buhrstone group, or second stage of the eocene. In general, some doubt rests upon the identity of species by Tuomey, but the following list of shells contained in No. 2 is copied, with emendations, from his Report: *Ostrea Carolinensis*, Con., *Venericardia planicosta*, *Protocardia Virginiana?* Con., *Volutilithes Tuomeyi*, Con. This bed represents the dark-colored loose sand of Piscataway, over which and next in succession lies the Marlborough rock, which corresponds to the "great Carolinian bed" of Ruffin, and the "calcareous strata of the Charleston basin" of Tuomey. The sand bed and condition of its fossils, as well as the similarity of some of its species, reminds us of the Bracklesham Bay locality in England, and the superimposed rock of the Bognor beds.

Although the *Aturia ziczac* is the only fossil of Oregon known to be identical with the New Jersey eocene, the vast distance between the localities will account for the variation; for the Continent was then as wide as from the Appalachian to the Rocky mountains, and seems to have been intersected by many rivers and fresh-water lakes, which have left an abundance of shells and mammalian remains entombed in the strata deposited by their waters. The Brandon fruits described by Hitchcock are all different from those of Shark River, but the conditions under which they flourished may account for this variation. They probably grew on high land, at some distance from the coast, whilst the station of the others was on low land along the shore, where Palms and Acacias scattered their fruit within reach of currents which swept them into the sea.

At present, the marine beds of this era are found to lie close to the Atlantic, and in Oregon they skirt the shore; but estuary deposits were observed by Meek and Hayden in Upper Missouri. The Shark River marl is an indurated clay, with disseminated grains of green sand, which are often smooth and shining, and the shells are all in the form of casts, which are distorted more or less. Portions of this clay are indurated, making it as difficult to break as the hardest limestone. Its thickness is yet unknown. The *Aturia* of this locality is discoid, which is the result of pressure, whilst the Oregon forms are broader, and one specimen approximates the normal form of the European shell.

Professor Harper describes a deposit on Chickasawhay River, Mississippi, which also is of similar geological age. "The *Nipadites* and *Cycadites* mixed with coniferous trees, and even oaks." "Stumps are seen rooted in the ground, as smooth and even as if not cut with an axe, but sawed with a sharp saw." "A little higher up, on the Chickasawhay River, occurs the most southern outcrop of the large eocene marl stratum. Above the marl lies a stratum of hard limestone, which contains abundance of an *Ostrea* of large size." In this description I recognize the strata on Savannah River, where the lignite is overlaid by the "great Carolinian limestone" group, and succeeded by the *Ostrea Georgiana*, which is found as far west as Cape St. Lucas in Lower California.

The lignite bed underlies the bluff at Vicksburg, where we find—1. lignite; 2. ferruginous rock, with *Ostrea Georgiana*, Conrad; 3. St. Stephen's lime-

stone, or Orbitolite limestone. eighty feet; 4. Vicksburg group, with a new species of Orbitolite,—*N. supera*, Conrad.

This formation appears at Cape Sable, near Annapolis, where, at about the water level, "under a stratum of sand, and resting upon an impermeable crust of ferruginous sandstone, lies imbedded in a layer of almost pure alumine, a forest of pine trees, thrown down by some ancient convulsion. The crust which forms the base of this aluminous layer is a little below the level of low tides and is of considerable hardness. The imbedded pines are converted into lignites more or less impregnated with sulphuret of iron. The central parts are generally transformed into pure metallic sulphuret, sometimes exhibiting in the hollow parts octohedral crystals of a yellowish metallic lustre and great hardness. The more remote the ligneous layers from the centre, the less they are saturated with sulphuret of iron. The external rays, as well as the cortical layers, are generally pure lignite, some compact and black, others retaining the color and friability of rotten wood. In some instances their texture seems to have suffered but little alteration: the central system, concentric rays, the bark and knots being perfectly discernible; even *fruits* are occasionally found in a pretty good state of preservation as to form."* The lignite is correctly placed in Morton's diagram as overlying the secondary marls. In Morton's paper the first published notice of the formation appeared, drawn up from the notes of Lardner Vanuxem, who was familiar with the strata in South Carolina.

Deshayes states that he has found no species of organic remains common to cretaceous and eocene strata in Europe or Asia, and I have no doubt that the destruction of life was total over the whole surface of the globe at the close of the cretaceous era. Deshayes, indeed, affirms that life has been five times destroyed and renewed in the past history of the earth. When we find evidence of surprising changes of level in the eocene period, the limited nature of a mixed fauna is remarkable, for we would expect to find it much more extensive at the base of the eocene. The bed of the Atlantic along the coast of the United States, from Cape May to the Gulf of Mexico, contains a mixture of recent and miocene shells, which, if elevated above the sea level would present a group of shells consisting of recent and extinct species, so like in preservation that the fossil could not be distinguished from the recent forms, except by one conversant with all the miocene shells.

Deshayes affirms of the Maestrich beds, "that there has been an accidental mixture of cretaceous and eocene; a degradation of a stratum of fossilliferous marl diluted in the bed of the tertiary sea at the time of the first deposit. The bed of the ocean, under our own eyes, shows an accidental mixture of this nature."

The Wilmington rock proves conclusively that this was the case in North Carolina. Eocene and cretaceous fossils are there mingled in a breccia. When I first saw this rock in 1832, no fracture or excavation revealed its true character; but the external resemblance to the Timber Creek limestone of New Jersey, with its corallines, was striking. The mixture of secondary and tertiary species in this breccia, shows that a disturbance occurred in the bed of the eocene ocean, which evidently, from Tuomey's account, extended into South Carolina. No one, I suppose, will tell us that the *Venericardia planicosta* existed in the cretaceous period, yet countless thousands may be observed at the base of the eocene. It is true that in Europe a series of strata, termed Upper and Lower Landenien and Heersien, are said to intervene between the chalk and eocene; but one of the characteristic fossils of the Upper Landenien occurs in the Shark River beds,—the *Cyprina Morrissi*, of Sowerby. It is therefore probable that the former system is merely an extension of the London Clay. Certainly, in the United States, there is no such system as the

* Durand, Journ. Phila. College of Pharmacy, v. 12, 1834.

Heersien, whilst Lyell found, in the Belgium Lower Landenien grey marl, a perfect specimen of the *Terebratulina gracilis*,—a well known chalk fossil,—together with *Ostrea (Exogyra) lateralis*, Nyst. Lyell remarks, that the Lower Landenien, at Folx les Caves, rests on the Maestrich chalk.

There is an extensive bed of lignite in Europe of eocene age, which Deshayes says forms a well-determined horizon with the long series of "sables inferieures." "Above the lignite appears a bed of fresh-water and marine shells, the horizon of which I believe to be the same as the lignite formation of the United States. They reveal a singular state of the globe at the commencement of the tertiary period, presenting a vast level region covered by a dense forest, in which palms and oaks grew side by side, interspersed with lakes and rivers and long shallow bays of salt water penetrating to the interior of the continents. This state of the globe was exhibited in Europe and America at the same time, and the land was little elevated above the sea level, except that in America the Appalachian and Rocky mountain ranges stood out from the vast plain.

The Shark River fossils are few in number of species, and generally imperfect casts, with small chalky portions of the shell occasionally remaining. A few of the bivalves have connected valves. About twenty-five species of shells and plants have been collected, of which I think six shells are identical with species of the London Clay and one of the Plastic Clay, *Cyprina Morrisii*.

Catalogue of Shells of Shark River,

Mactra ———.
Cyprina Morrissii.
Dione ———.
Yoldia protexta, C.
Axinæa
Crassatella
Venericardia perantiquua *Con.*
Avicula annosa, *Con.*
Pinna ———.
Pecten ———.
Ostrea ———.
Aturia ziczac, *Sowerby.*
Nautilus Lamarckii, *Desh.*
Priscofusus ———, *Con.*
Volutilithes mutata, *Desh.*
Surculi annosa, *Con.*
Sycotopus Smithii, *Sowerby.*
Onustus extensus, *Sowerby.*
Hippochrenes columbaria ? *Defrance.*
Acteonema prisca, *Con.*
Architectonica ———.
Pleurotomaria perlata, *Con.*

Fish.

Cœlorhynchus rectus, *Agassiz.*

Catalogue of the EOCENE ANNULATA, FORAMINIFERA, ECHINODERMATA and CIRRIPEDIA of the United States.

BY T. A. CONRAD.

Annulata.

SERPULA, Lin.

S. ornata, Lea, Cont. to Geol. 37, 1, 5. Claib.
S. squamulosa, C. J. A. N. S., vii, 149. Claib.

SPIRORBIS, Daudin.

S. tubanella, Lea, Cont. to Geol. 36, 1, 4. Claib.

DITRUPA, Berkeley.

D. subcoarctata, Gabb., J. A. N. S., 2d series, 386, 67, 47. Texas.

Foraminifera.

TRILOCULINA, D'Orbigny.

U. lineata, C., n. s.